SCIRT Rebuilding Infrastructure

LEARNING LEGACY

Lessons learned from one of New Zealand's most challenging civil engineering projects: rebuilding the earthquake damaged pipes, roads, bridges and retaining walls in the city of Christchurch 2011 - 2016.

Ferry Road Stormwater Brick Barrel Christchurch: Report on Archaeological Monitoring

Story: Archaeology

Theme: Programme Management

A report which details the archaeological investigations carried out during the course of SCIRT projects 11115 and 11159, wastewater renewal work and storm water repair work on Ferry Road.

This document has been provided as an example of a tool that might be useful for other organisations undertaking complex disaster recovery or infrastructure rebuild programmes.

For more information about this document, visit www.scirtlearninglegacy.org.nz

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Christchurch City Council
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FERRY ROAD STORMWATER BRICK BARREL CHRISTCHURCH: REPORT ON ARCHAEOLOGICAL MONITORING

NZHPT AUTHORITY 2012/321EQ

SCIRT 11115 AND 11159

HAMISH WILLIAMS
UNDERGROUND OVERGROUND ARCHAEOLOGY

SEPTEMBER 2016

UNPUBLISHED REPORT FOR THE FLETCHER CONSTRUCTION COMPANY, MCCONNELL DOWELL AND CHRISTCHURCH CITY COUNCIL

INTRODUCTION

Subsequent to the earthquake on 22 February 2011, wastewater and stormwater pipes across Christchurch were damaged, necessitating replacement. On 26 September 2011 New Zealand Historic Places Trust (NZHPT) issued a global authority (2012/321eq) under section 11 of the Canterbury Earthquake (Historic Places Act) Order 2011 to the Christchurch City Council. This authority was issued to allow the council, in conjunction with the Stronger Christchurch Infrastructure Rebuild Team (SCIRT), to undertake various earthworks in Christchurch. An authority was required as these earthquake related infrastructure repair works had the potential to impact known or unknown archaeological sites. During the course of wastewater renewals in Woolston in October 2015 as part of SCIRT project 11159, a short section of the Ferry Road stormwater brick barrel sewer was removed in order to install a wastewater pipe. From November 2015 to April 2016 damaged sections of this Ferry Road stormwater brick barrel were subject to segment repair replacement as part of SCIRT project 11115 (Figure 1 and Figure 2). This report details the archaeological investigations of this 19th century brick barrel stormwater conduit that took place during the course of SCIRT projects 11159 and 11115.

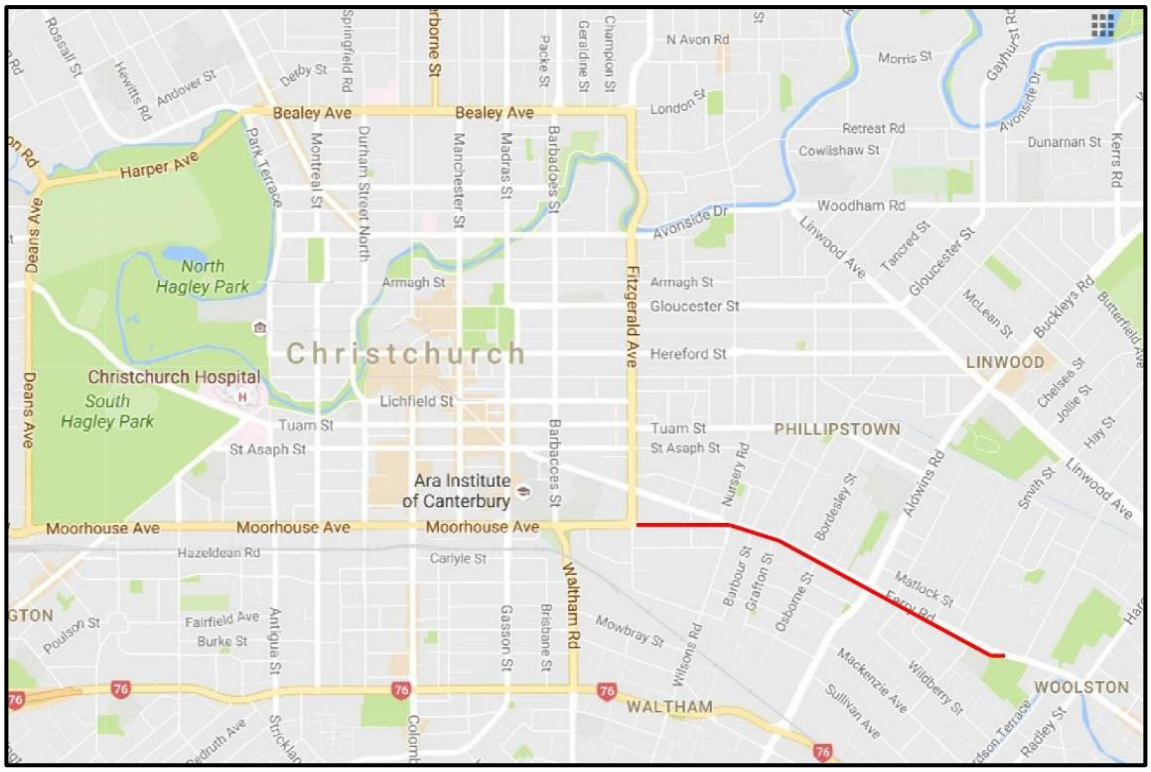

Figure 1. Central Christchurch, showing the location of Ferry Road stormwater brick barrel (red line). Image: Google Maps.

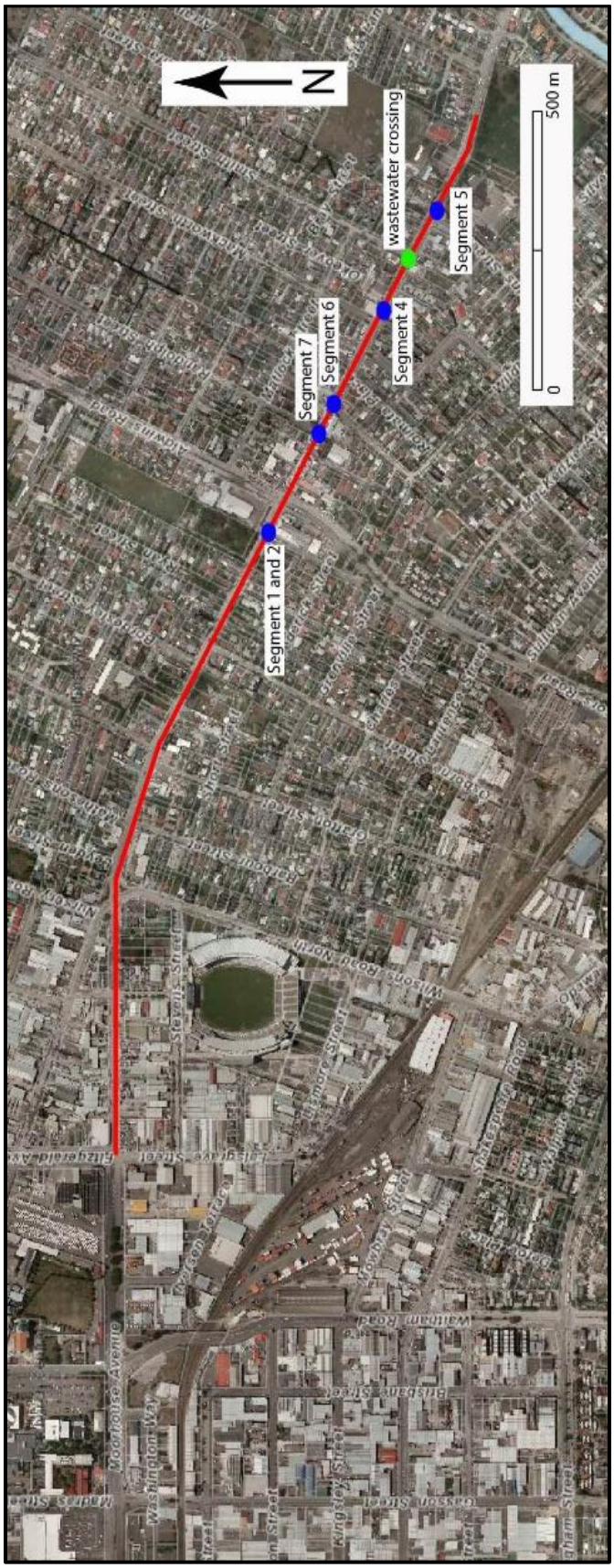

Figure 2. 2016 aerial imagery showing the location of the 1878 Ferry Road stormwater brick barrel in red, location of the SCIRT 11159 wastewater crossing works area in green, and in blue, the locations of the SCIRT 11115 segment repairs. Image: after SCIRT n.d.

HISTORICAL BACKGROUND

Construction of the Ferry Road stormwater sewer began in October 1878, and was completed in late June 1879 (*Press* 4/10/1878: 3, Star 25/6/1879: 4). It was designed by William Clark, consulting engineer to the Christchurch Drainage Board and replaced an earlier stormwater conduit that was known simply as the Ferry Road drain. This open drainage ditch ran largely parallel to and on the southern side of Ferry Road, and was built in the late 1850s by the provincial government in order to remove water from the swampy southern part of Christchurch. The 'South Belt drain' (recorded as archaeological site M35/1316), which after 1862 was administered by the Christchurch Town Board (later the Christchurch City Council), discharged into the Ferry Road drain west of the intersection of Ferry Road and the East Belt (now Fitzgerald Avenue; Figure 3). Both the Ferry Road drain and the covered sewer that replaced it had their outfalls into the end of Bell's Creek, which discharged directly into the Heathcote River, very close to the Heathcote/Christchurch Quay (archaeological site M36/135), located close to what is now the intersection of Richardson Terrace and Ferry Road).

Subsequent to the passing of the Roads Board Ordinance of 1864 the Ferry Road drain became the responsibility of the Heathcote Road Board. In addition to their responsibilities for forming and maintaining all the roads in the district, they also had the duty "to form cleanse and maintain all drains, watercourses streams, ditches and the like not being on private property within the district" (Watson 1989: 34). By 1870 the Ferry Road drain was found to be wholly inadequate for the purpose for which it was originally intended – as population increased, it was transformed into an open sewer. It not only received stormwater and the overflow from artesian wells and springs, but also night soil, domestic rubbish and trade wastes (*Press* 22/4/1870: 2).

The Heathcote Road board delivered an ultimatum to the Christchurch City Council in December 1870. The council was given 14 days to end the discharge of sewage from its South Belt drain into the Ferry Road drain or it would be blocked off. The council suggested that further negotiations be entered into to resolve the matter, but the board refused on the grounds that it was "no part of its duty to say what shall be done with the sewage of the City of Christchurch" (Watson 1989: 34). Informed that the council was seeking a Supreme Court injunction to stop the blocking, the board ordered its surveyor to do the work a week before its ultimatum was to expire. This action backfired and was a most expensive and filthy exercise for the board. An injunction was granted by the Supreme Court and the road board was ordered to remove the 50 drayloads of earth it had tipped into the drain (Watson 1989: 35).

The Supreme Court was to later return a verdict in the road board's favour and made a legally binding agreement that the city council was to construct a covered drain to take its sewage directly to the estuary and not through the road board's district. In return for doing this, the council was to be allowed to continue using the Ferry Road drain for a period of no longer than two years. Although some ratepayers were upset that this arrangement was to carry over for an additional six months (the council's new outfall drain was not completed on time), as soon as the outfall drain was completed in late February 1874 the Ferry Road drain was immediately blocked up (*Press* 3/3/1874: 2). Although available historic records do not elaborate in any detail as to where this Ferry Road drain blocking/unblocking/reblocking incident took place, it is suspected that this was on Ferry Road east of the intersection with the East Belt, which marked the boundary between the council and road board's administrative districts.

The Ferry Road drain blocking/unblocking/reblocking incident was to prove a catalyst for the formation of the Christchurch Drainage Board in late 1875. At a meeting held on 10 June 1875 representatives of the Christchurch City Council and the various road boards decided that the only feasible solution to the mounting drainage problems that were affecting the whole of Christchurch was the creation of a separate legal body to deal solely with drainage matters.

Tenders for the construction of the Ferry Road sewer were first advertised in March 1877 (*Press* 27/3/1877: 4), but by May the drainage board had withdrawn the call for tenders for the sewer on account of the concerns of local inhabitants/ratepayers, problems with securing the outfall through private land, and indecision about the best alignment and location of the sewer (*Press* 21/5/1877: 1, *Star* 21/6/1877: 2). With these issues finally resolved by early July 1878, they readvertised the tender for works (*Press* 18/7/1878: 1). There were only two tenders for construction as submitted to the drainage board, and the tender of Messrs Lake and Beard was accepted on 3 August 1878 (*Press* 3/8/1878: 3).

Work began soon after Lake and Beard won the contract, although quicksands made work slow – this was 2 chains from the Bells Creek outfall where there was "old swamp" (*Press* 4/10/1878: 3). By mid-February 1879 construction had reached the Wilsons Road intersection, and from this point the sewer deviated from the line of Ferry Road, to cross what was then a paddock to reach the South Belt, terminating at what is now the intersection of Fitzgerald and Moorhouse avenues (*Star* 14/2/1879: 4).

A section of the Ferry Road sewer was reported to have been damaged by the earthquake that hit Christchurch on 1 September 1888. In addition to damage caused to the East Belt sewer main, a section of the Ferry Road sewer was found to be "badly cracked for a distance of a chain, commencing about 30ft from the outlet end". In this case, drainage board engineer Mr E. Cuthbert reported that the cracking that occurred was to be "cleaned out and made good with strong cement mortar as a temporary measure" (*Press* 26/9/1888: 6).

Figure 3. Part of the 1877 plan of Christchurch, showing the location of the South Belt drain (in red) in relation to the upstream end of the Ferry Road drain (in blue). Image: Strouts 1877.

11159: ARCHAEOLOGICAL MONITORING OF EARTHWORKS

2015 works to install new wastewater pipes in the greater Linwood/Woolston area as part of SCIRT project 11159 took place with Drains and Developments as the main subcontractor. As part of this project, a new wastewater line was installed across Ferry Road to connect the existing wastewater line located on the southern side of Ferry Road to new wastewater mains pipe on Smith Street (located on the other side of Ferry Road). The installation of this new pipe necessitated the removal of a short section of the brick barrel at the location of the road crossing. In October 2015 a new manhole was constructed atop the brick barrel at the location where the wastewater crossing was to be made, after which a wire-cutting saw was used to remove a 700 mm long section of the brick barrel (Figure 4, Figure 5, and Figure 6). Neither the excavation atop the brick barrel prior to construction of the manhole chamber walls nor the wire cutting removal of the section of the brick barrel was monitored by an archaeologist, but Hamish Williams from Underground Overground Archaeology visited site on 23 October 2015 to inspect the removed section of brick barrel. Subsequent to the construction of the new manhole (which is recorded on Christchurch City Council's infrastructure assets database as

stormwater structure ID# 1324) the northern and southern walls of the manhole access chamber were core drilled in order to install the new wastewater pipe.

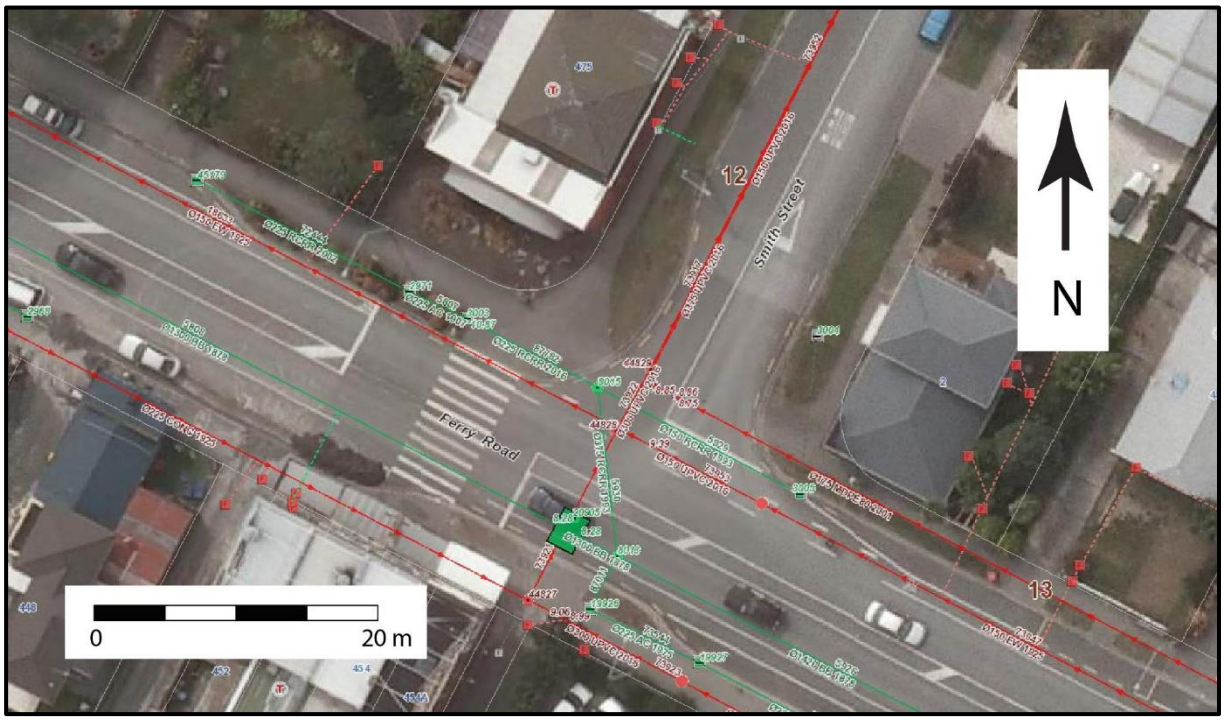

Figure 4. The Ferry Road/Smith Street intersection, showing the wastewater pipes (in red) and stormwater pipes (in green). The location of the new manhole atop the Ferry Road stormwater brick barrel, where the wastewater pipe crossing was made, is indicated by the green square. Image: SCIRT n.d.

Figure 5. Looking east along Ferry Road, with the completed manhole atop the brick barrel in the foreground.

The brick barrel as exposed at the location of the new manhole had an internal diameter of 1300 mm and was formed of a single skin of standard sized red bricks and was fully encased in unreinforced

concrete (Figure 7). The concrete below the brick invert was up to 380 mm thick, and above the upper arch up to 130 mm thick (Figure 8). Standard sized hand-pressed bricks marked 'WN' were used in the construction of the brick barrel, laid in a standard running bond (Figure 9). These bricks were manufactured by William Neighbours, one of the largest of Christchurch's brick making firms that was in operation in the 19th century. William Neighbours began making bricks in Christchurch from 1863 (Matt Hennessey, pers. comm. 12/9/2016). The presence of an earthenware drainage pipe below the invert was noted by the crew, although the remaining in situ parts of this pipeline were not visible at the time of the archaeologist's site visit and nor was the removed section retained. This pipeline would have been installed at the time of construction to remove groundwater from the works area when the brick barrel was being built. At the time of the site visit, there was an estimated 300 mm of water in the invert of the sewer, believed to be tidal in nature.

Figure 6. The eastern side of the brick barrel as exposed after wire cutting.

Figure 7. The removed section of brick barrel.

Figure 8. A section of the upper crown of the brick barrel, showing the arrangement of bricks haunched in concrete.

Figure 9. One of the marked 'WN' bricks used in the construction of the brick barrel.

Discussion

Despite the limited size of the excavation and access restrictions, the removal of a 700 mm long section of the Ferry Road stormwater brick barrel provided the first opportunity for the archaeological investigation of this 19th century brick barrel conduit. The method of construction is different to other brick barrel conduits constructed by the Christchurch Drainage Board in the 19th century, some of which have been subject to archaeological investigations as part of the SCIRT programme (for some examples, see Williams 2015, Williams 2016). That the brick barrel was bedded, and fully haunched in concrete is a method of brick barrel construction that has not been observed anywhere else in Christchurch to date. Further, the majority of brick barrel sewers that have been investigated to date have been of an oviform (egg shaped) cross section, with a concrete invert and upper crown of bricks (Figure 10).

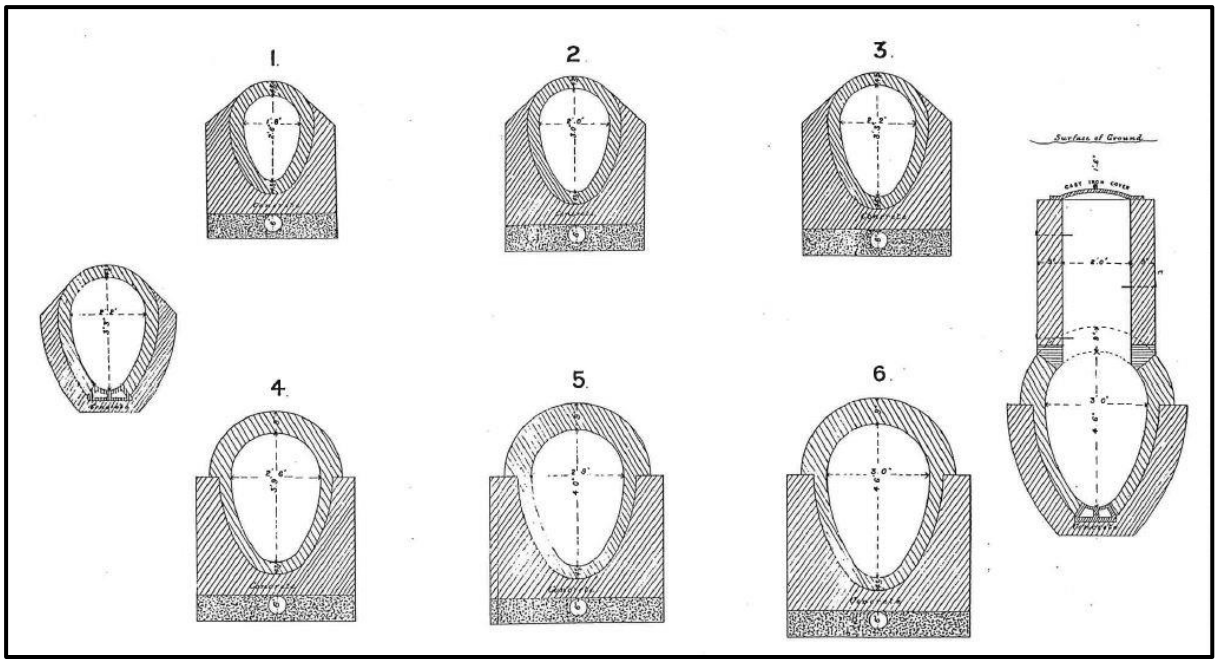

Figure 10. Examples of the oviform brick and concrete sewers designed by drainage board engineer William Clark. Image: Clark 1878.

11115: ARCHAEOLOGICAL MONITORING OF EARTHWORKS

The replacement of six sections of the Ferry Road stormwater brick barrel that were damaged by the earthquakes took place as part of SCIRT project 11115. This work took place from November 2015 to April 2016, with Kwikshift as the main earthworks subcontractor. The location of each of these segment repair locations is shown in Figure 2, and a synthesis of information about each of these segment repairs is provided in Table 1 below.

Table 1. Information about the segment repairs to the Ferry Road brick barrel that took place as part of SCIRT project 11115.

Segment repair number	Segment repair completion date	Asset ID (SCIRT n.d.)	Adjacent address	Diameter (mm)	Repair length (m)
S1	09/12/2015	7495	352 Ferry Road	1300	8
S2	09/12/2015	7500	354 Ferry Road	1300	3.7
S4	16/2/2016	5809	1/430 Ferry Road	1300	19.6
S5	26/2/2016	5911	487 Ferry Road	1420	9.5
S6	11/12/2015	5956	396A Ferry Road	1300	2.5
S7	1/4/2016	73285	392 Ferry Road	1300	14.8

The segment repairs took place within a sheet-piled area 4 metres wide, with excavations extending to a depth of up to 3.2 metres. Groundwater was removed from the excavation area by means of dewatering spears, and the damaged sections of the brick barrel were broken out with a mechanical excavator equipped with a hydraulic breaker attachment (Figure 11).

A wire cutting saw was used to cut a clean section through the brick barrel at both the upstream and downstream ends of each of the segment repair locations. Reinforced concrete rubber ring jointed pipes of 1350 mm diameter were used to replace the damaged sections of the brick barrel, with the exception of at segment repair location 5, where the brick barrel was of a larger diameter (1420 mm), and 1600 mm diameter pipes were used (Figure 12). Where subsoil drainage pipes were exposed below the invert, these were replaced with 150 mm diameter PVC pipes before the replacement concrete pipes were installed.

Out of these six segment repair locations, archaeological monitoring was only carried out at segment repair locations 1, 2, and 6, and of these only a close inspection of the brick barrel was made at segment repair location 6, after the wire cutting was completed. Because of this, most of the archaeological information about the brick barrel as detailed in this part of the report is derived from observations made at this segment repair location. Here, detailed photographs of the transected brick barrel were taken, and a stratigraphic profile was recorded (Figure 13). These archaeological investigations were carried out by Hamish Williams from Underground Overground Archaeology.

Figure 11. Segment repair 1 under excavation, looking northwest.

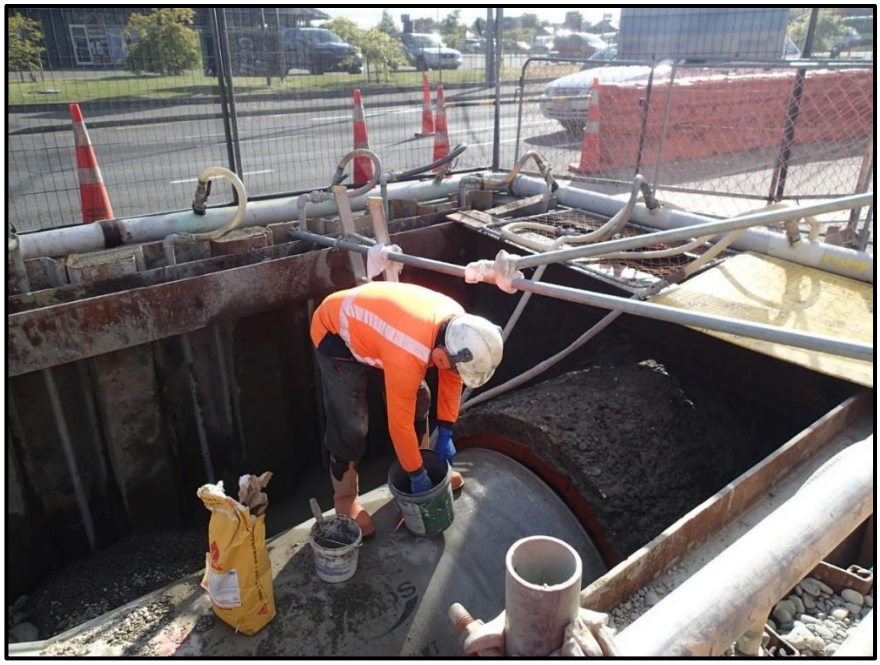

Figure 12. The southern end of the segment repair 1 works area, showing the first of the replacement concrete pipes under installation.

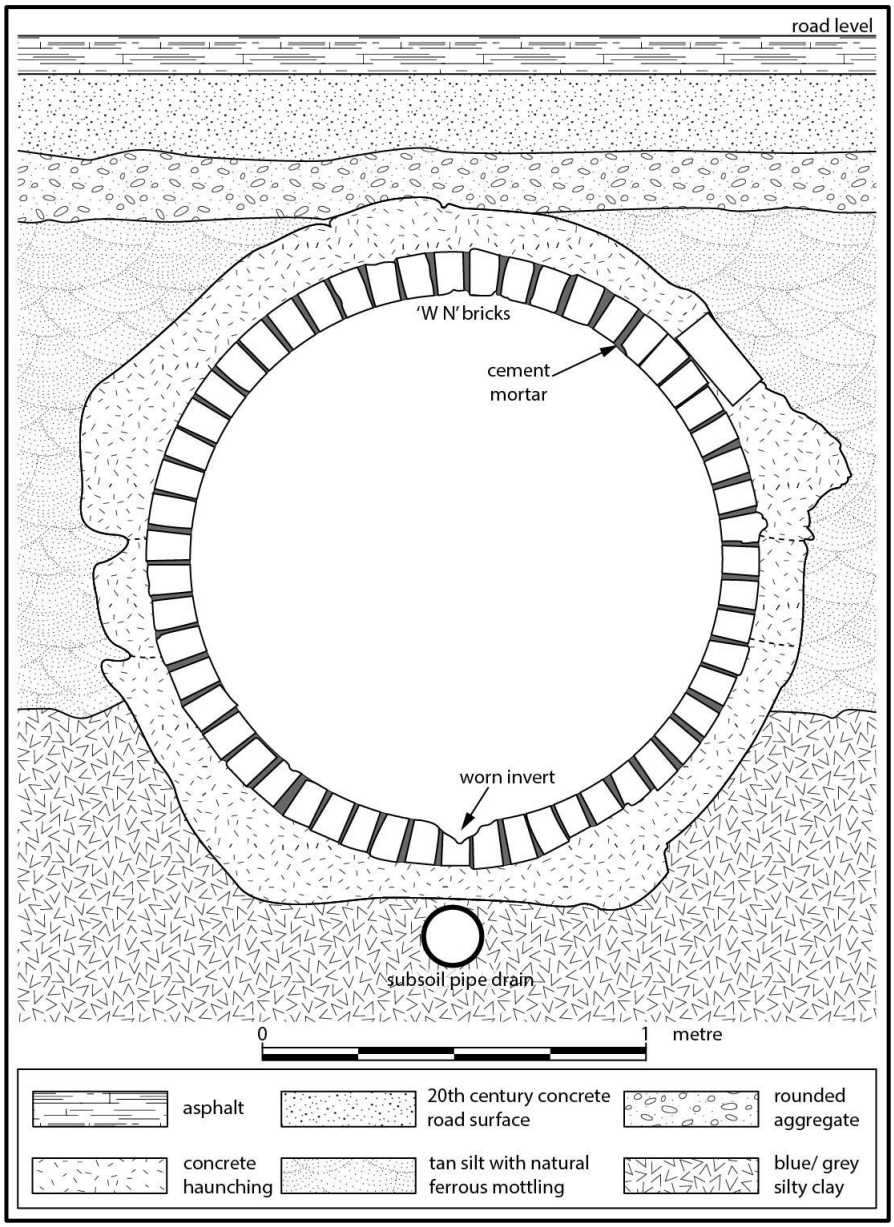

Figure 13. Stratigraphic detail of the Ferry Road stormwater brick barrel as recorded at the eastern end of the segment repair 6 works area.

Archaeological investigations of the brick barrel at segment repair location 6 took place on 27 November 2015, after excavation had been completed to 2845 mm (Figure 14). The top of the brick barrel was exposed at a depth of approximately 600 mm. The modern road asphalt surface had been laid directly atop of an earlier 20th century concrete road surface, which had an aggregate base course of approximately 160 mm thickness. No metalled road surface potentially dating to the 19th century period was exposed during the course of this work, and it is suspected that any evidence of such a layer would have been removed during the course of 20th century road surfacing renewals.

The brick barrel had been laid directly into the natural blue-grey silty gleysol clay substrate, which was waterlogged. Atop this was a tan coloured silt that had natural ferrous mottling – this mottling is indicative of mean groundwater level (Figure 15). The unreinforced concrete below the brick invert was up to 240 mm thick, and this had been laid atop a 150 mm diameter unglazed earthenware pipe drain. The pipes were of the standard socket and spigot type. This subsoil pipe drain had been laid directly into the silty gleysol clay with no differential pipe bedding or backfill. As this pipe drain was removed prior to the site visit being carried out, little can be said about these pipes, including whether

they carried any impressed manufacturer's marks. It is suspected that these would have been of local manufacture, and are probably much the same as examples found below a replaced section of the 1882 Moorhouse Avenue oviform brick barrel (Williams 2015). These Moorhouse Avenue examples were also unglazed, had hand applied sockets, and did not carry any impressed manufacturer's marks.

As was observed during SCIRT 11159 works as well as at segment repair locations 1 and 2, standard sized hand pressed bricks marked 'WN' and manufactured locally by brickmaker William Neighbours were used in the construction of the brick barrel, laid in a standard running bond (Figure 16 and Figure 17). The concrete atop the upper arch was up to 130 mm thick, and contained rounded greywacke stones as the aggregate component. Bricks were found to be incorporated into the concrete as well (Figure 18). The presence of these 'WN' bricks was later confirmed across the other segment repair locations. 34 mm of the uppermost portion of the brick at the invert was completely abraded away (Figure 19). The wear to the invert was likely caused by the passage of grit and other particulate matter that had been carried through the sewer over the course of the 137 years that it had been in operation.

Figure 14. Looking northwest across the sheet-piled segment repair 6 excavation area.

Figure 15. The stratigraphy exposed adjacent to the eastern (downstream) end of the brick barrel at segment repair location 6. Note the two differential natural silty subsoil layers, and groundwater pooling in the foreground.

Figure 16. One of the marked WN bricks used in the construction of the brick barrel.

Figure 17. The inside of the brick barrel at the eastern end of segment repair 6, showing the arrangement of the bricks in a standard running bond.

Figure 18. Section of the upper crown of the brick barrel. Note the rounded aggregate in the concrete, and the brick incorporated as aggregate.

Figure 19. Detail of the invert at the eastern end of segment repair location 6. Note the groove formed in this brick, caused by the passage of grit and other particulate material washed into the sewer.

Discussion

From close examination of the wire cut eastern end of the brick barrel at the location of segment repair 6, it is possible to work out how the brick barrel was likely built 137 years ago. The steps are as follows.

1. The trench was excavated by hand. No evidence of any in situ trench shoring was encountered during the course of the earthworks, though based on the depth at which the brick barrel was located, and the silty substrate into which it was laid, shoring would have been necessary, unless the sides were battered.
2. The subsoil pipe drain to remove groundwater from the works area was installed in a shallow trench dug at the base of the main trench, and then backfilled. Because there was no mortar laid between individual pipe components, groundwater would have infiltrated through the joints and been removed via this pipeline.
3. The concrete of the invert was poured into the roughly shaped base of the trench. A semi-circular shaped timber formwork (with the curved side of this formwork orientated downwards) was used to shape the upper face of this concrete in preparation for laying the bricks that would form the sewer invert.
4. After removal of the timber formwork and with the concrete sufficiently cured, the first of the bricks for the invert was laid (with cement mortar) directly onto this concrete. While the mortar was setting, another section of concrete invert was poured.
5. A second semi-circular timber formwork was set in place, with the curve orientated upwards. The bricks of the upper arch would be laid atop this formwork, possibly with a thin layer of sand between the bricks and the formwork to stop the cement mortar from sticking, to allow the formwork to be easily removed.
6. After the mortar of the upper brickwork arch had sufficiently cured, the formwork would be removed, and repositioned in preparation for laying the next stretch of the sewer's upper arch.

7. Concrete would be poured atop the completed section of brick arch, in at least three separate pours. It is suspected that the reason for this is to facilitate the easy removal of the timber formwork, though this is pure supposition. That the concrete of the brick barrel had been laid in more than 2 successive pours was evident not only in the wire cut ends of segment repair 6, but also at the location of the new manhole and wastewater crossing (Figure 20). It is suspected that this is a consistent feature of this brick barrel conduit along its whole length.
8. Once the upper arch had been fully haunched in concrete, and this concrete joined to the concrete of the sewer invert, the completed section of the brick barrel would have been backfilled with the excavated material, and the metalled road surface reinstated.

Figure 20. At top, the Ferry Road brick barrel as wire cut at the eastern end of segment repair 6, and at bottom, the downstream end at the location of the SCIRT 11159 manhole. The evidence for the successive concrete pours exposed in both these locations is highlighted with red squares.

CONCLUSION

The installation of a new wastewater pipe crossing across the Ferry Road brick barrel stormwater sewer as part of SCIRT project 11159 and the repair of six localised earthquake damaged sections of this 19th century stormwater conduit as part of SCIRT project 11115 provided archaeological

information about this 19th century stormwater conduit, particularly about how it had been formed and how it differed from other similar brick barrel conduits in Christchurch. Approximately 59 metres of this stormwater brick barrel was either removed or replaced during the course of these SCIRT projects, representing approximately 2.6% of its total length. As a result of this work, the 1878 stormwater brick barrel has been recorded on ArchSite as site M35/1552 (see attached).

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NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

ARCHSITE archaeological site recording scheme

Summary Site Record

NZAA SITE NUMBER: M35/1552

SITE TYPE: Administrative

SITE NAME(s): Ferry Road Brick Barrel sewer

Record last updated: 27/11/2015

SITE COORDINATES (NZTM) Easting: 1572777 **Northing:** 5178967 **Source:** On Screen

IMPERIAL SITE NUMBER: **METRIC SITE NUMBER:** M35/1552

Finding aids to the location of the site

Below the west bound lane of Ferry Road, as well as that portion of Moorhouse Avenue between Wilsons Road and Fitzgerald Avenue.

Brief description of the site

Brick barrel sewer. Construction of the Ferry Road stormwater sewer began in October 1878, and was completed in late June 1879.

Condition of the site when last visited

Below surface - Surface evidence has been obliterated, however, there is likely to be subsurface material present. Note that this is different from a destroyed site.

This report contains a summary of the information about this site held in ArchSite.

For a complete Site Record Form containing all the recorded information, please contact the ArchSite Coordinator.

For further information please contact:

ArchSite Coordinator, PO Box 6337, DUNEDIN

admin@archsite.org.nz

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